Claims

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- 1 1. An apparatus, comprising:
 - a. an upper element;
 - b. a lower element, wherein the upper element and the lower element are configured to be brought together to form a processing volume; and
 - c. a seal energizer configured to maintain the upper element against the lower element to maintain the processing volume, the seal energizer configured to control a sealing pressure in a seal-energizing cavity that varies non-linearly with a processing pressure generated within the processing volume.
 - 2. The apparatus of claim 1, wherein the seal energizer is configured to minimize a non-negative net force against one of the upper element and the lower element above a threshold value, the net force following the equation P1*A1 P2*A2, wherein P1 equals the sealing pressure, P2 equals the processing pressure, A1 equals a cross-sectional area of the seal-energizing cavity, and A2 equals a cross-sectional area of the processing volume.
- 1 3. The apparatus of claim 2, wherein the seal energizer is configured to maintain a difference P1 P2 substantially constant during a processing cycle.
- The apparatus of claim 1, wherein the seal energizer comprises a first cavity and the seal-energizing cavity, the first cavity coupled to the seal-energizing cavity, the seal energizer configured so that a first pressure generated within the first cavity generates a second pressure in the seal-energizing cavity larger than the first pressure.

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- 1 5. The apparatus of claim 2, wherein the cross-sectional area A1 is larger than the cross-sectional area A2.
- 1 6. The apparatus of claim 1, further comprising a means for generating supercritical conditions coupled to the processing volume.
- The apparatus of claim 6, further comprising a CO₂ supply vessel coupled to the processing volume.
- 1 8. The apparatus of claim 1, wherein the upper element and the lower element form a supercritical processing chamber.
- 1 9. The apparatus of claim 1, wherein the seal energizer comprises a hydraulic piston coupled to the lower element and configured to maintain the processing volume.
- 1 10. An apparatus, comprising:
- a. an upper element;

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- b. a lower element, wherein the upper element and the lower element are configured to be brought together to form a processing volume; and
 - c. means for maintaining a seal between the upper element and the lower element to maintain the processing volume, the means for maintaining a seal configured to control a sealing pressure in a seal-energizing cavity that varies non-linearly with a processing pressure generated within the processing volume.

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- 1 11. A method of maintaining a processing volume, the method comprising the steps of:
 - a. generating a processing pressure within a processing volume; and

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- b. controlling a sealing pressure to form and maintain a processing volume, wherein during a processing cycle the sealing pressure is varied non-linearly with the processing pressure.
- 1 12. The method of claim 11, wherein the sealing pressure is related to the processing pressure
 2 by the equation ΔF = P1*A1 P2*A2, wherein P1 equals the sealing pressure, P2 equals
 3 the processing pressure, A1 equals a cross-sectional area of a seal-energizing cavity, and
 4 A2 equals a cross-sectional area of a processing volume, and the sealing pressure is
 5 varied to maintain ΔF above a threshold value.
- 1 13. The method of claim 12, wherein a cross-sectional area of the processing volume is 2 smaller than a cross-sectional area of the seal-energizing cavity.
- 1 14. The method of claim 11, wherein the step of generating a processing pressure comprises containing a high-pressure processing fluid in the processing volume.
- 1 15. The method of claim 14, wherein the high-pressure processing fluid comprises supercritical carbon dioxide.
- 1 16. The method of claim 12, wherein the step of controlling a sealing pressure comprises 2 generating a hydraulic pressure in the seal-energizing cavity.